

Appln. No.: 10/001,421  
Amendment Dated October 24, 2003  
Reply to Office Action of September 10, 2003

END919970013US2

**Remarks/Arguments:**

By this Amendment, applicants have amended claim 11 and cancelled claims 12-14. Claim 11 is pending.

**Telephone Interview**

Applicants acknowledge with appreciation the courtesies extended by Examiner Vu to applicants' counsel, Daniel N. Calder, and inventor, Joseph Milewski, during the telephone interview held on Wednesday, October 22, 2003. Proposed amended claim 11 was submitted to Examiner Vu prior to the interview, and has been further amended herein.

**Claim Objection**

Claim 11 has been objected to for reasons set forth in numbered paragraph 1 of the Office Action. Following the Examiner's suggestion, the basis for the claim objection has been overcome.

**Claim Rejections Under Section 102**

Claims 11-14 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Hoebener; and claims 11-14 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Crafts. By this Amendment, applicants have overcome the Section 102(b) rejections.

Claim 1 is directed to an intermediate interconnection structure for a semiconductor chip. The intermediate structure as defined in claim 11 calls for a nonreflowed solder assembly including the following elements:

- a Pb-rich ball attached to the semiconductor chip and having an exposed surface; and
- a thin cap layer of Sn on the exposed surface of the Pb-rich ball,
- the Sn layer having a thickness of less than 10.2 µm (0.4 mils) and having a melting temperature lower than that of Pb so that Sn from the thin layer and Pb from the ball are diffused and intermixed after reflowing and annealing to form a solder assembly.

As pointed out to Examiner Vu during the telephone interview, applicants' invention is directed to an intermediate interconnect structure for a semiconductor chip of a nonreflowed solder assembly including a Pb-rich ball with a thin cap layer of Sn on the Pb-rich ball. Applicants specifically define the Sn layer to a thickness of less than 10.2 µm. Applicants are

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not claiming the solder assembly that may result from further reflow and annealing of the nonreflowed solder assembly as defined in claim 11.

In addition, applicants have pointed out to Examiner Vu in the telephone interview that the advantage of this thin cap of Sn on the Pb-rich ball is that deposits of Sn are not found on the outer surface of the Pb-rich ball during reflow and subsequent reflows. Thus, the specifically defined thin cap layer of Sn prevents subsequent deposits of Sn on the Pb-rich ball during subsequent reflows which applicants have found to cause contact problems with the semiconductor chip and circuit cards.

The intermediate structure which applicants' claim is a Pb/Sn, lead rich, ball with a thin Sn cap prior to reflow. The thickness of the Sn cap defined as less than 10.2  $\mu$ m is important to this intermediate structure for initial reflow connection and then future connection reliability. For low temperature solder reflow processing, there must be a tin cap to achieve a reflow and connection at a lower temperature than would be needed by just a lead rich ball alone, but applicants have discussed that the cap must be thin enough such that substantially all of the Sn is ultimately diffused into the ball and intermixed throughout, such that the solder connection subsequently acts like a high melt solder connection during follow on reflow processes. This is important to maintain the initial connection and future reliability of the connection after subsequent reflow processes such as module or card touch up, rework, or other such operations that require the assembly to exceed the low temperature that was initially used to reflow the solder connection created by the lead rich ball with the tin cap.

Applicants note that the Crafts Patent and the Hoebener Patent describe solder balls. For example, solder ball 19 is shown in Fig. 8 of the Crafts Patent and a solder ball 12 is shown in Fig. 12 of the Hoebener Patent. But neither of these references teach or suggests the intermediate interconnect structure of applicants claimed invention of a nonreflowed solder assembly wherein a thin cap layer of Sn of a thickness of less than 10.2  $\mu$ m is deposited on the Pb-rich ball thereby to prevent electrical connection problems during subsequent reflow of a solder ball assembly, as a result of deposits of Sn on such solder assemblies. It is applicants position, therefore, that the intermediate interconnect structure defined by claim 11 is simply not taught or suggested in the Crafts and Hoebener Patents. Applicants request that the Section 102(b) rejections be withdrawn.

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Based on the foregoing remarks and amendments, applicants respectfully submit that claim 11 is in condition for allowance. Reconsideration and allowance of claim 11 is respectfully requested.

Respectfully submitted,



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DNC/vj

Dated: October 24, 2003

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